Transistors built from ultra-thin 2-D materials take a step forward

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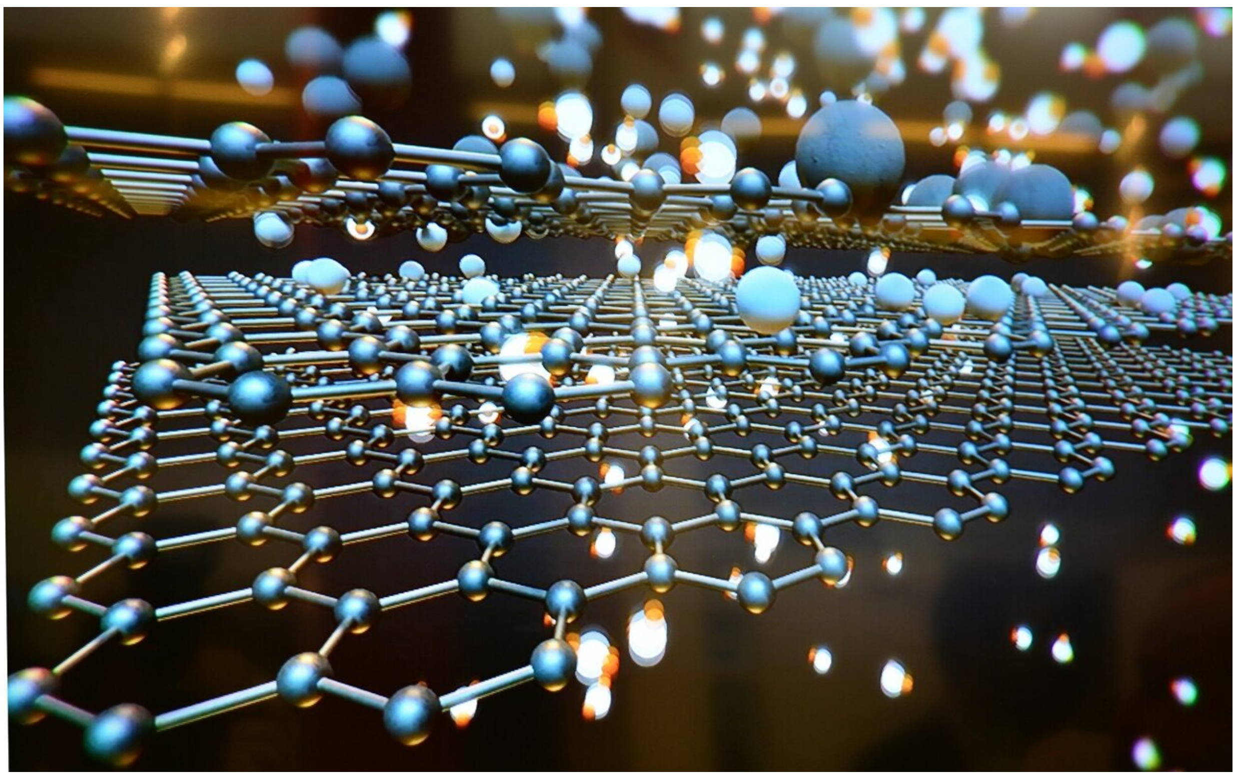

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wo-dimensional materials can be used to create smaller, high-performance transistors traditionally made of silicon, according to Saptarshi Das, assistant professor of engineering science and mechanics (ESM) in Penn State's College of Engineering.

Das and his collaborators report in *Nature Communications* on tests to determine the technological viability of transistors made from 2-D materials. Transistors are tiny digital switches found in cell phones, computer circuits, smart watches and the like.

"We live in a digital and connected world driven by data," Das said. "Big data requires increased storage and processing power. If you want to store or process more data, you need to utilize more and more transistors."

In other words, as modern technology continues to get more compact, so must transistors, which are considered the building blocks of computer processing.

Silicon, a 3-D material that has been used to manufacture transistors for six decades, cannot be produced any smaller, according to Das, which makes its use in transistors increasingly challenging.

"It is difficult to manufacture silicon transistors that are only a few atoms thick," Das said.

Past research studies determined that the 2-D materials, as an alternative, can be manufactured 10 times thinner than the silicon technology currently in practice.

In the current study, researchers grew monolayer molybdenum disulfide and tungsten disulfide using a metal organic chemical vapor deposition technique obtained from the 2-D Crystal Consortium NSF Materials Innovation Platform (2DCC-MIP) at Penn State.

To understand how the new 2-D transistors perform, the researchers analyzed statistical measures as seen in relation to threshold voltage, subthreshold slope, ratio of maximum to minimum current, field-effect carrier mobility, contact resistance, drive-current and carrier saturation velocity.

The tests confirmed the viability of the new transistors, proving the technology can now move forward to manufacturing and development, according to Das.

"These new transistors can help make the next generation of computers faster, more energy efficient and able to withstand more data processing and storing," Das said.

More information: Amritanand Sebastian et al. Benchmarking monolayer MoS_2 and WS_2 field-effect transistors, *Nature Communications* (2021). DOI: 10.1038/s41467-020-20732-w

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